Remarks

Claims 1-11 remain pending. This amendment corrects minor typographical errors inadvertently made in several paragraphs of the Specification as filed. The amendments are made in accordance with 37 CFR 1.121. Marked-up copies of the paragraphs that delineate the changes are provided in the attached section entitled *Version With Markings To Show Changes Made.*

The Examiner is invited to contact the undersigned should there be any questions or need to discuss this matter.

Respectfully,

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Version With Markings To Show Changes Made

Changes to the paragraph at page 3, lines 1-12 are as follows:

An existing system for which better synchronizers are desirable is a special version of CPM known as dual-h, 4-ary, full-response. The meaning of these terms follows from the mathematical model of a signal having the specified CPM waveform, $s(t)$, given below.

$$\cancel{s(t) = \sqrt{\frac{2E_s}{T}} e^{j\Psi(t,\underline{\propto})}}$$

$$\underline{s(t) = \sqrt{\frac{2E_s}{T}} e^{j\Psi(t,\alpha)}}$$

with E_s representing the waveform's energy over its interval T, and $\cancel{\Psi(t,\underline{\propto})}$ $\underline{\Psi(t,\underline{\alpha})}$ is the phase function. The function $\cancel{\Psi(t,\propto)}$ $\underline{\Psi(t,\alpha)}$ depends on the data sequence $\cancel{\underline{\propto} = (\text{---} \propto_{i-1}, \propto_i, \propto_{i+1}, \text{---})}$ $\underline{\alpha = (---\alpha_{i-1}, \alpha_i, \alpha_{i+1}, ---)}$ where each of the data symbols is randomly and independently selected from the four possibilities (± 1, ± 3), hence "4-ary." Also, $\cancel{\Psi(t,\underline{\propto})}$ $\underline{\Psi(t,\alpha)}$ depends on two constants h_0 and h_1, called "modulation indexes," and a function $q(t)$, called the "phase response function," as follows.

$$\cancel{\Psi(t,\underline{\propto}) = 2\pi h_0 \sum_i \propto_{2i} q(t-2iT)}$$

$$\underline{\Psi(t,\underline{\alpha}) = 2\pi h_0 \sum_i \alpha_{2i}\, q\,(t-2iT)}$$

$$\cancel{+ 2\pi h_1 \sum_i \propto_{2i+1} q(t-2i-T)}$$

$$+ 2\pi h_1 \sum_i \alpha_{2i+1}\, q\left(t - 2i - T\right)$$

For "full response" CPM, the function $q(t)$, is as shown in Figure 1.

Changes to the paragraph at page 6, line 10 up to page 7, line 6, but not including line 6, are as follows:

Signal 22 is a corrected frequency offset value that is represented by $y(kT_s)$, also a set of discrete time samples, produced by multiplying signal 18 [$x(kT_s)$] by signal 24 at multiplication node 20, where signal 24 represents an estimated frequency correction factor. At the initialization of the operation of frequency synchronizer 10, signal 24 may be provided with an initial value of zero. Signal 24 is a discrete time sequence represented by $e^{-j2\pi k\hat{\nu}T_s}$. The resultant product from node 20 is signal 22, and represents a corrected version of signal 18 [$x(kT_s)$], with the correction taking the form of subtracting from signal 18 an estimate $\hat{\nu}$ produced by synchronizer 10 of the unknown frequency offset ν from the actual carrier frequency of CPM signal $s(t)$. Next, signal 22, i.e., the sequence $y(kT_s)$, is filtered by a digital filter 26 having impulse response $h(kT_s)$. The impulse response $h(kT_s)$ is specified by the following equations:

$$h(kT_s) = kF_2(kT_s), \text{ for } -N \le k \le -1$$

$$= kF_3(kT_s), \text{ for } 1 \le k \le N$$

$$= 0, \text{ for } k = 0 \text{ ~~and~~ } \underline{\text{or}}\ |k| > N,$$

where N represents the number of samples for each information symbol interval, and where F_2 and F_3 are functions defined as follows:

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$$
\begin{aligned}
F_2(k_1T_s, k_2T_s) = \quad & \frac{1}{4}\left[1+\frac{(k_2-k_1)}{N}\right]\left[\cos\frac{3\pi h_0(k_2-k_1)}{N}+\cos\frac{\pi h_0(k_2-k_1)}{N}\right. \\
& \left.+\cos\frac{3\pi h_1(k_2-k_1)}{N}+\cos\frac{\pi h_1(k_2-k_1)}{N}\right] \\
& +\frac{1}{4\pi}\left\{\left[\frac{h_1}{3(h_0^2-h_1^2)}+\frac{3h_1}{h_0^2-9h_1^2}\right]\sin\frac{3\pi h_1(k_2-k_1)}{N}\right. \\
& +\left[\frac{h_1}{9h_0^2-h_1^2}+\frac{h_1}{h_0^2-h_1^2}\right]\sin\frac{\pi h_1(k_2-k_1)}{N} \\
& +\left[\frac{h_0}{9h_1^2-h_0^2}+\frac{h_0}{h_1^2-h_0^2}\right]\sin\frac{\pi h_0(k_2-k_1)}{N} \\
& \cancel{+\left[\frac{h_0}{3h_1^2-h_0^2}+\frac{3h_0}{h_1^2-9h_0^2}\right]\sin\frac{3\pi h_0(k_2-k_1)}{N}}\bigg\} \\
& \left.+\left[\frac{h_0}{3(h_1^2-h_0^2)}+\frac{3h_0}{h_1^2-9h_0^2}\right]\sin\frac{3\pi h_0(k_2-k_1)}{N}\right\} \\
& = F_2[(k_2-k_1)T_s]
\end{aligned}
$$

and where:

$$
\begin{aligned}
F_3(k_1T_s, k_2T_s) = \; & \frac{1}{4}\left[1-\frac{(k_2-k_1)}{N}\right]\left[\cos\frac{3\pi h_0(k_2-k_1)}{N}+\cos\frac{\pi h_0(k_2-k_1)}{N}\right. \\
& \left.+\cos\frac{3\pi h_1(k_2-k_1)}{N}+\cos\frac{\pi h_1(k_2-k_1)}{N}\right] \\
& +\frac{1}{4\pi}\left\{\left[\frac{h_1}{3(h_1^2-h_0^2)}+\frac{3h_1}{9h_1^2-h_0^2}\right]\sin\frac{3\pi h_1(k_2-k_1)}{N}\right. \\
& \cancel{+\left[\frac{h_1}{h_1^2-9h_0^2}+\frac{h_1}{9h_1^2-h_0^2}\right]\sin\frac{\pi h_1(k_2-k_1)}{N}} \\
& +\left[\frac{h_1}{h_1^2-9h_0^2}+\frac{h_1}{h_1^2-h_0^2}\right]\sin\frac{\pi h_1(k_2-k_1)}{N} \\
& +\left[\frac{h_0}{h_0^2-9h_1^2}+\frac{h_0}{h_0^2-h_1^2}\right]\sin\frac{\pi h_0(k_2-k_1)}{N} \\
& \cancel{+\left[\frac{h_0}{3h_0^2-h_1^2}+\frac{3h_0}{9h_0^2-h_1^2}\right]\sin\frac{3\pi h_0(k_2-k_1)}{N}}\bigg\}
\end{aligned}
$$

$$+\left[\frac{h_0}{3(h_0^2-h_1^2)}+\frac{3h_0}{9h_0^2-h_1^2}\right]\sin\frac{3\pi h_0(k_2-k_1)}{N}\Bigg\}$$

$$= F_3[(k_2-k_1)T_s]$$

Changes to the paragraph at page 7, line 7 through page 8, line 38 are as follows:

Since filter 26 is non-causal, a time delay of D sampling intervals is incorporated into $h(kT_s)$ of filter 26. By way of example, D may be set equal to 2*N*, but other choices are possible as might be suitable for particular applications. The filter 26 is thus shown as $h[(k-D)T_s]$ so as to incorporate the necessary delay. The output of filter 26 is a signal 28 represented as a discrete time sequence $w(kT_s)$, which is transformed at step 29 into signal ~~29~~ 30, the conjugate sequence $w^*(kT_s)$. Signal 28 represents a filtered corrected frequency offset value. Signal 22 [$y(kT_s)$] is also delayed D sampling intervals by the delay 32, which produces signal 33, represented as $y[(k-D)T_s]$ and described as a delayed corrected frequency offset value. The multiplier 34 forms a signal 36 which is a discrete time sequence and is the product of signals 30 and 33, i.e., $w^*(kT_s)\ y[(k-D)T_s]$. Signal 30 is described as a conjugate product value. Signal 36, a delay conjugate value, is provided as an input to error generator 38.

Changes to the paragraph at page 9, lines 4 through 9 are as follows:

Referring to Figure 3, frequency synchronizer 10 may be implemented as a sequence of executable operations in a discrete time digital data processor 50 which provides signal 22 (a corrected frequency offset) to a digital receiver 52, which outputs a signal 54. Signal 54 is a data sequence that represents an improved estimate of the data

encoded in signal 12, or $s(t)$. The operation of frequency synchronizer 10 may be repeated any integral number of times to provide increasingly refined values for the corrected frequency offset value as represented by signal 22.